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PROCEEDINGS - METHANE/BIOGAS CONFERENCE

March, 1982

Prepared for

Montana Department of Natural Resources and Conservation
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METHANE/BIOGAS

CONFERENCE

FLATHEAD COUNTY FAIRGROUNDS
County Fair Kitchen Building
Kalispell, Montana

WEDNESDAY, MARCH 17, 1982

9:00 am	Registration & coffee
10:00 am	General over view of Methane - Richard C. Waybright Ted Landers Kurt Vause
11:30 am	Lunch
12:30 pm	Dairy Methane Production, Systems, Storage and Slurry Utilization on the Mason Dixon Farms - Richard Waybright
2:30 pm	Coffee
3:00 pm	Agricultural Methane Production Systems, Storage, Slurry Options - Ethanol-Methane Integration - Ted Landers

THURSDAY, MARCH 18, 1982

8:30 am	Engineering Design, Material and Energy Balances, Site Considerations, Materials of Construction and Operation, Maintenance Programs - Kurt Vause
12:30 pm	Lunch
1:00 pm	Use of Surplus Gas, Markets for Gas and By-Products, Financing, Specific Problems. General Discussion and Questions - Ted Landers, Kurt Vause, Ricahrd C. Waybright

SPEAKERS

RICHARD C. WAYBRIGHT - Dairyman, designer of continuous flow, low-cost, methane system on his dairy.

TED LANDERS - Developed low-cost biogas generators, alcohol stillage digestors, designed efficient engine-generator to run off biogas.

KURT VAUSE - Low cost digestion systems, alcohol-methane integrated systems, experience with industrial and municipal waste.

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Montana Department of Natural Resources and Conservation

METHANE BIO-GAS CONFERENCE

March 17, 1982

10:00 A.M.
TED LANDERS

Initial raw material can be grasses or manure. If the material has gone through a gut, it is hydrolicized. The higher the temperature, the faster the bacteria works. Bacteria have two ranges: Normal - up to 95°, and Thermophilic - up to 140°. You want your temperature hot. Balance your carbon and nitrogen ratio to around 30 to 1 to operate, keeping a warm, insulated tank. Don't let the tank get too acid. If you leave manure in the digester for 2 weeks, you will get as much gas as is economically feasible. Most of the digesters are designed around a 15 to 20 day retention; however, you can go as low as 12 days and get good returns from them.

RULES OF THUMB:

1. Optimal way to use this gas is to make electricity. If you have 10 dairy cows at 1400 pounds, you should be able to run a 1 KW generator continuously.
2. Twenty-eight 700 pound beef cattle equal 1 KW.
3. 160 finishing hogs at 120 lbs. equals 1 KW.
4. 2000 four pound layers equal 1 KW.

Take the KW unit and multiply it times $500 to get dollar return in electricity per year. This is assuming the digester is running every day of the year and electricity is .06¢ per kW hr. A 100 cow dairy farm spends $100,000 for manure handling equipment. A digester can reduce odor and make electricity at the same time without costing electricity to run. For hog manure, use 15 to 20 days for odor reduction.

QUESTION: Is manure containing urine a problem?

ANSWER: No. You want all the fecal material you can get. Urine is important.

RICHARD C. WAYBRIGHT

Had 2600 acres and 2000 head of dairy cattle. He noticed gas bubbling from the large manure pits; thus the idea of using the gas.

Built the first digester 20 feet wide X 15 feet deep X 92 feet long, holding capacity of 165,000 gallons. Put manure from animals in digester and started to get gas in the first 3 days. Got 25,000 cubic feet of bio-gas per day. Emptied first digester and re-built at the end of one year.

COMMENT: After operating the digester for 2-2½ years, he would build one even if he did not get energy from it. There is a big advantage in fertilizer value after going through a digester. It enhances the nitrogen value of the manure. You can grow good crops without using commercial fertilizer. He once needed to apply lime occasionally, but not after using this liquid. After about three years, you should check for phosphorous content. Digester greatly reduces manure odor around the farm.

QUESTION: How does the climate here compare to the climate in Pennsylvania?

ANSWER: We had -15° for 2 weeks in January. It gets up to 100° in the summer time. I would build a digester even if living in Alaska. It takes less than ½ of the heat from the motor/generator to maintain digester temperature.

QUESTION: What time span do you use to keep your manure in the digester?

ANSWER: It was initially designed to hold for about 15 days. We found if we held it for 10 days and fed faster, we could get more gas from the digester. Operated it at about 110° to 115°. Holding any less than 10 days showed a drop off in gas production.

QUESTION: Was there more odor?

ANSWER: The faster you feed, the less breakdown. If you feed 12% solids at 15 day retention time, it will come out 9%. At 12% you will get more gas. Temperature affects the solids.

QUESTION: Do you mix in straw or bedding?

ANSWER: Estimated 5% of feed for digester was sawdust shavings. It reduces gas production because it breaks down slowly. Straw breaks down faster.

QUESTION: Do you have a dryer to make bedding?

ANSWER: We pump it through a squeezer to squeeze the liquid out.

QUESTION: Are you concerned about nitrate build-up and salt levels in ground water?

ANSWER: The nitrogen is in a form that is the most available to the plant and would suspect that there is less build-up than in commercial nitrogen use. Since we started using manure water, I'm convinved that the plants take it up.

QUESTION: Is the manure water the effluent?

ANSWER: Yes, plus additional water that is collected in the holding lake. About 1/3 effluent to 2/3 rain water is what we are spraying. DOLLARS & CENTS: Save about $30,000 worth of bedding per year and save about $30,000 to $35,000 worth of nitrogen fertilizer cost. You also save on electricity. Useing about 2200 KW per day on the farm - I am disconnected from utility company. Could have pay back in 2 years were it not for our initial mistakes in building. Have reduced the labor requirements on the farm for the disposing of manure. You don't have to be an engineer to keep a digester functioning. If you can shovel manure down a hole, you can make a digester work. It's simply a case of getting your act together.

KURT VAUSE

A thing to remember about digesters - it has been proven that the building and operating of a digester does not require vast technical knowledge. The more simple you make your system, the better it is. Keep it easy to operate and maintain. What it is basically, is a place where you keep your organic matter for about 10 days.

QUESTION: Do you need a strainer before it goes into the mixing tank?

ANSWER: No, manure and urine equals a good mixing tank. Effluent is discharged to a lagoon or receiving tank. The gas that comes from the digester is routed to its point of use or to gas storage, if you have one.

RULES OF THUMB:

1. The more simple you make your digester, the better your gas use. Use readily available materials.
2. There must be some use for the gas where the digester is located - on site.
3. Digesters are more successfully installed when you have a manure waste problem; such as the dairy farmer, hog farmer, feed lots, etc. Feed lots have been reasonably successful, but they require several pumps, tanks, and a variety of other appurtenances.

QUESTION: What about safety? I heard there have been accidents in California?

ANSWER: It is one of the safest pieces of equipment to use. It can be scrubbed easily. Typically, the gas that is produced in a digester varies in amount throughout the day. You can store this gas in a compressor.

Continuous digester system means to load every day or every other day. Batch system means you have basically one load, and the material remains in the digester. You must remove the contents. In the liquid form, the batch system is not practical.

QUESTION: Unless you are loading continuously, are you putting batches in?

ANSWER: Yes. Keep solids concentration at 12% - prevents separation of effluent.

QUESTION: Do you have separation when held in a lagoon?

ANSWER: Just had black scum when the lagoon was emptied. You might get more separation with a hog farm than with a dairy farm.

QUESTION: Does sterilization, necessary for hog farms, affect the digester operation?

ANSWER: It could.

QUESTION: Does the temperature increase the period of digestion?

ANSWER: The lower the temperature, the longer you have to keep the waste in the digester. As you decrease the temperature, you have to increase the time.

QUESTION: Generally, is the pH above 7 in all?

ANSWER: Depends upon the waste you are using. No problem with pH on dairy manure. It is only when the acid formers create acid too fast that you get a drop in pH.

QUESTION: Do you monitor pH inside the digester?

ANSWER: Yes, you can. We did at first, but learned that pH is not a problem.

QUESTION: H_2S - what happens - is it scrubbed out?

ANSWER: You can scrub it out or it might volitalize on its own and the same applies to ammonia too.

QUESTION: What kind of pH does H_2S have?

ANSWER: Insignificant. The scrubber will remove it.

QUESTION: Do you take manure water and pump it directly on the field?

ANSWER: No, it goes through the holding lake first.

QUESTION: Using a regular irrigation system?

ANSWER: Right. The effluent handles beautifully in irrigation systems with slurry guns.

QUESTION: Are you running central pivot irrigation?

ANSWER: Yes, no problems.

March 17, 1982 - 12:30 P.M.

WAYBRIGHT - MASON DIXON DAIRY

The dairy uses a flushing system, which is additional work for the digester. You have to de-water the manure when you use a flushing system as opposed to the straight manure. (Showed clip of a 12 foot deep, 50 foot square holding tank) No problems with it in severe winter conditions. Holding capacity 300,000 gallons. This dairy gets enough electricity from it's system to pump manure water through the four center pivots covering 500 acres and to move the whole system around. Had about $5,000 worth of oil saving just this winter using exhaust from bio-gas fed equipment - heat exchanger, using the heat from the motor.

QUESTION: Why are you going to a circular underground tank on your 3rd digester?

ANSWER: It is more economical to build a round container. It is not necessary to go with insulation because, within a few weeks, the digester has heated the surrounding ground anyway.

POINT: Retention - one time heat up and it doesn't matter how long you keep it in there. At 15 days you get 65% of the potential bio-gas from it. You can keep it for 30 to 35 days in the tank, however, this new one is a 500,000 gallon digester.

QUESTION: Are you going to use a plastic cover on the new one?

ANSWER: It will be underground with a concrete lid.

QUESTION; Are you going to use the gas as it comes out?

ANSWER: Yes, or put under pressure to store.

QUESTION: Did you have any trouble with that bag? (referring to digester #2?

ANSWER: Have had it for 2½ years with no trouble at all.

QUESTION: Would you insulate the sides underground?

ANSWER: Just to frost depth.

QUESTION: Where do heat pipes fit in on #3?

ANSWER: Keep them near the bottom.

QUESTION: What would you use for water proofing?

ANSWER: No Water proofing.

QUESTION: Will H_2S corrode the concrete digester?

ANSWER: You may have to worry about that eating away at it.

QUESTION: Do you have to shut tank down and clean it out?

ANSWER: I don't anticipate ever cleaning it out. Would go with 3" pipe for heating and believe it has a 20 year life span.

QUESTION: Will animal hair cause trouble?

ANSWER: No, hair would float to the top and never go down on bottom? It is high in protein and, eventually, would go back into the effluent.

QUESTION: Have you ever had scum problem?

ANSWER: Yes, went thermophyllic. Got up to 132° in 3 weeks time. At that point, we were making gas like mad. We opened cover and found 3 inches of crust on it. The same thing happened again in the same length of time. We had to get it down to less than 120°.

QUESTION: Do you have an air lock seal?

ANSWER: You need less than 2" down in liquid to get a liquid seal. It's simple.

QUESTION: Are the pipes inside steel?

ANSWER: Yes.

QUESTION: Could they be PVC?

ANSWER: I suppose so but don't recommend PVC.

QUESTION: Do you use any starter to get started?

ANSWER: You can. It's just a big joke though. If it makes you feel better, go ahead.

QUESTION: You don't use any mechanical agitation?

ANSWER: No, there is nothing more unpleasant to work with than a mechanical device covered with manure.

QUESTION: How do you keep the "zero effort" going - valves?

ANSWER: We have a radiator. If the temperature gets up, the radiator disperses it.

QUESTION: Would an agitator stop scum problem at high temperature?

ANSWER: If the mechanical agitator kept working.

QUESTION: If you had bad percolation of your water, would you have to seal it to keep water from coming in?

ANSWER: No, if you build it about 12" higher than surrounding ground. You will have used hydrolic pressure so the water won't come off.

QUESTION: Do you find you keep wanting a bigger capacity with each digester you build?

ANSWER: Yes.

QUESTION: Are you eliminating your previous digester?

ANSWER: No indeed. Might hook them all together. This is said to be impossible. Too hard to control the CO_2 formation.

QUESTION: Any trouble with gas pipes leaking?

ANSWER: Use PVC pipe only.

QUESTION: Can you smell them if they leak?

ANSWER: No.

QUESTION: Do you have fire traps in the lines?

ANSWER: Any regulator has a screen which acts as a trap.

QUESTION: How do you get it in the motor?

ANSWER: Pump it in under 2 pounds pressure.

QUESTION: Do you take the effluent from the bottom?

ANSWER: No, take effluent right off the top.

QUESTION: How do you start your digester initally?

ANSWER: Put in enough manure to get about ½ way up and start heating. Keep on adding to it. Have never been able to make one explode.

March 17, 1982 - 3:00 P.M.

TED LANDERS

Designed the first digester using four old tanks bought for $35.00 each and Ozark vegetation. The vegetation took longer, but made as good a gas as any. Explained various systems designed by Perennial Energy.

QUESTION: If line goes down on induction motor, does it shut off?

ANSWER: Automatically.

QUESTION: What about H_2S?

ANSWER: We always scrub. If sulphur gets in the engine, the acid can eat out the bearings and exhaust system. We suggest the equipment be kept oiled and checked regularly.

At one time Landers got federal money to develop small digesters for small farmers. After going through three, they were eventually abandoned by the users, they came to the conclusion that the small digesters just aren't worth it. It takes too much time for pay back and the work to keep them going is constant. Most people wouldn't bother.

(Described a very large dairy digester system with manholes at Fairgrove Farms in Sturges, Michigan.)

QUESTION: How do you seal the manholes?

ANSWER: They go below the liquid level and we lose only about ½% of the gas. (Comment made to harvest your fiber off your lagoon to use for bedding.)

QUESTION: How much does separation equipment cost?

ANSWER: Approximately $14,000 complete, but can be cut down to $11,000 by eliminating some of the extras. Solids that come off the separator are basically fiber and have no food value; however, with a centrifuge, you can get the single cell protein that can be used for feed and as a substitute for corn, silage, barley, alfalfa and cotton seed meal. Value is $65 to $75 per ton, dry weight. Some feed lots and dairies are using the digester just to make single cell feed. Different laws exist per state.

Conversation returned to H_2S.

QUESTION: Will the iron sponge in the scrubber work continuously?

ANSWER: Yes, with an air pump on it.

QUESTION: Would you coat the inside of a digester?

ANSWER: Yes, with a material such as that used in a septic tank.

QUESTION: Would stillage alcohol have any affect on you inside coat?

ANSWER: No.

QUESTION: Do you have any concern about osmosis of ground water coming into the tank?

ANSWER: No, it has styrofoam on the outside. This is in contention with Waybright. Insulation gives you more heat to use elsewhere for a better return on your gas.

QUESTION: Could you run through a thermophyllic to get more liquid fertilizers?

ANSWER: There just isn't enough information on it to say.

QUESTION: Were you concerned about pumping out air on first filling?

ANSWER: No. When the engine ran, we knew it was good.

QUESTION: How did you heat the tank to begin?

ANSWER: Ran engine on propane.

QUESTION: Why didn't you use PVC pipe?

ANSWER: Didn't even consider it. Iwouldn't feel safe. Gut hunch.

QUESTION: What about pH sensors?

ANSWER: Don't need it. Don't worry about pH. Co_2/CH_4 Ratio is best indication of digester health.

QUESTION: How do you put in your temperature sensors?

ANSWER: Have temperature probe.

QUESTION: With lots of stillage, will it effect pH in tank?

ANSWER: Yes, if 100% stillage, should add some manure to it.

QUESTION: Do any of your customers want to pull out the CO_2?

ANSWER: No, not worthwhile.

THURSDAY, MARCH 18, 1982

KURT VAUSE

The U.S. was not the first to use digesters. The principles have been applied in China, India, Taiwan, and the Philippines for several years on small scale. There are approximately 4 or 5 million plants in operation in China alone. In the United States the impetus for small-scale farm digesters came from 1973 on while previously digestion technology was used mainly in municipal waste water systems.
NOTE: Small scale = 5 to 5 tons a day; large scale = 5 to 500 tons a day.

QUESTION: What's the difference in Aerobic and Anaerobic?

ANSWER: Aerobic involves the addition of O_2 in order to stabilize waste. Use requires large amount of energy input to treat waste. Anaerobic is a net energy producer requiring energy input.

APPLICATION BY SMALL SCALE:

1. Easy to operate
2. Low cost
3. Provides usable
4. Waste treatment system reduction
    a. Odor reduction
    b. Fly breeding control
    c. Nutrient conservation
    d. Volume reduction

SUMMARIZE COST: Generation, gas cleaning, gas storage, energy conservation and quality utilized.
INCOME: Reduction in labor requirements, pollution control, volume reduction, energy value, ease of operation, residue recovery and aesthetic value.
BATCH - influent going into a tank that doesn't have to have a mixer. Material stays in tank much longer. You get evolution of methane and CO_2. Batch load type system is good for vegetation material rather than manure.

QUESTION: Do you have to physically clean out before starting over again?

ANSWER: Yes.

PLUG FLOW CONCEPT: Influent enters one end and exits the other end. Theoretically, there is no short circuiting in the digester system, (influent passes through digester). Designing digesters: The basis of design is detention time. The hotter the temperature, the less time the material stays in there - up to a point.

The amount of solids you use per day (don't over feed at any time), heating and heat balance, degree of mixing - no mixing (plug flow type partial mixing, complete mixing.

COMMENT: Ted Landers showed that he didn't need to mix in his digester.

MANAGEMENT & CONTROL:

1. Big item - temperature, pH (don't worry about it), alkalinity and VA Conc.
2. Toxicity - important to hog farmers.
3. Nutrient requirements. Carbon/nitrogen ratio should be 30-1. On thin stillage, you might need to add manure or other material.

QUESTION: How fast do bacteria multiply in digester?

ANSWER: It will take about 2 weeks to get gas production going after feeding on a gradual basis (assumes you start with raw manures). Once you have that two or three weeks period, you may assume you have a good bacteria growth.

QUESTION: What is the normal life of bacteria?

ANSWER: Several hours to a couple of days. They multiply very rapidly and will adjust to varied temperature changes. They are very capable of adjusting to any change. Bacteria have been known to even go dormant (at around 70^{o}) for several months. At this point, Waybright says when his digester goes down, it only takes hours to get gas - not weeks.

QUESTION: Do you have a pre-heat system? (talking to Waybright).

ANSWER: No.

COMMENT: K. Vause: Waybright's information and experience is contrary to everything in the book. Waybright's conclusion is that a lot of data was collected from "table-top digesters", which could render different results than one in the field.

Back to original topic - history.

They are incorporating a variety of principles overseas; namely, ease of handling manure, high quality substitute fertilizer, producing other products such as plankton, algae, etc., liquid effluent for irrigation purposes. Real development started back in India or China with cow dung. From their simple concepts more technical digester were designed.

(Several slides were shown of digesters in India, and the problems were pointed out.) Waybright interjected that many of the non-working digesters of the world are not working because they do not use heat at all and most of them are built above ground depending on weather temperatures. (Other digesters were shown of Indonesia, U.S., and Philippines.)

(Slides were shown on the first large attempt to build a digester from off-the-shelf equipment for a farm in Washington in 1978.) It was pointed out just how costly this was. The total price was $118,000 and it was very complicated.

QUESTION: Do you think that is a good storage system?

ANSWER: It is nothing more than a huge balloon and they seem to be happy with it. It is above ground in a round, reinforced tank.

QUESTION: Wouldn't H_2S eventually corrode the tank?

ANSWER: It is scrubbed.

QUESTION: How often do you replace iron filings and sawdust?

ANSWER: Regenerate it once a year by letting it aerate for one week.

QUESTION: Does a large amount of gas pressure affect the digester?

ANSWER: Don't worry about that.

QUESTION: How much conversion is there to convert natural gas to bio-gas?

ANSWER: Slightly de-rated.

QUESTION: What kind of life would you expect from those bags?

ANSWER: The Hypoline 45 people say 20 years. Waybright says his bag has slightly less expected life than Hypoline, but it takes 300 lbs. of pressure to puncture it.

(Slides were shown of a huge digester system in the Philippines.) The newest installation was underground, no heat and hand mixed with rods on top that were manually manipulated for that purpose. The Philippine system had a sequence of ponds. They were using algae for feed.

QUESTION: How did they seal off the mixing rods to keep gas from coming up?

ANSWER: They were capped.

It was shown that the Philippine farmer had used an auto engine, converted to pump to his irrigation system.

QUESTION: Has this type been run long enough to know what it does to the engine?

ANSWER: Used well over 5 years with no problem.

QUESTION: Running constantly?

ANSWER: Yes.

QUESTION: Does it go through a carburetor?

ANSWER: No, through gas/air mixer.

COMMENT: Power equipment using natural gas has no carbon after combustion and makes for long wearing engines.

COMMENT BY WAYBRIGHT: York Sewage Company ran lp motor for 6 years and valves really didn't need grinding but I did it anyway.

NOTE: The Philippines don't use scrubbing, they use a filter for safety.

COMMENT: Many of the features of the systems shown would not be applicable to Montana. In this area, you are going to have to go underground. Waybright's system would be best.

COMMENT: Fifty cows is the break-over point for economics. This data was taken from Cornell and other places, but Ted believes it would take more than that to make it economical. You have a sizeable investment for a small operation.

COMMENTS BY WAYBRIGHT: The digester may become a necessity for waste handling in the future. To start with, a digester has to be one that really doesn't take any labor. The manure handling system at Mason Dixon is handled in 15 minutes a day; feeding, checking oil (with dip stick), etc. You should have this same maintenance time on a small scale to make it worthwhile. Don't have a system that needs repairs and replacements often. It should be underground with heat pipes so that it will work as a digester rather than a septic tank.

Heads of governemnt from China and India came to Mason Dixon. They admitted that their digesters did't work. The collection system in China is that kids gather cow chips, mix by hand with water, and go from there. Even so, they found in both countries that they could grow and export more rice with the effluent fertilizer. They said they came to Mason Dixon Farms because they had seen the data on gas production and had not been able to get near it. Twenty thousand cow dairy herds in China had 14,000 workers with average milk production of 4500 pounds per year per cow. They never attempted to build large digesters because they didn't know how to build them. They haven't figured out why their digesters didn't work - basically, they weren't heated.

Regarding 30 to 50 head of cattle: Ultimately, you want trouble free equipment. You're going to have $3000-$4000 worth of concrete, $1000 worth of pipes and end up with under $10,000 worth investment. 50 cows X 65 CF bio-gas a day = 3,250 Ft. X 365 days = 1,186,000 Ft. Yr. (use 550 BTU per CF) 6.5 X 10^8 BTU Yr. This is 45 hundred gallons of deisel fuel a year - $4500 worth of gas per year.

$4500 Yr.
2500 Nitorgen/Yr.
$7000 Revenue
1000 Mgmt. Cost
$6000 Yr. Income

COMMENTS: If you don't use that much diesel and nitrogen a year, you would have to be creative and find other uses for the has and effluent to make it pay back. Some ways are home heat, efficient effluent use - new research being done in Israel on air-ponics, green house use, in China they are using it to feed cat fish with much success. Farmers are going to have to get away from traditional ways of thinking and create new profit makers. Agriculture, to survive, will have to develop a new approach. Got 6 cuts off hay (Mason Dixon Farms). Had to cut so often because it would get rank so quickly - 3 weeks. Actually got 12 tons of dry hay equivalent per acre last year. Protein content was 21% to 22%.

QUESTION: What is the normal level of protein?

ANSWER: 8% to 10%.

QUESTION: What about fuel cells to generate electricity?

ANSWER: That's down the road. When we use up the major easy sources of fossil fuels, we still will have to go with renewable energy.

QUESTION: If you are going to hire an engineer to show you how to build a digester for 50 cows, it isn't going to be worth it. You need Extension Service to publish pamphlets showing you how to build a digester yourself.

COMMENT: B. McCallum: The universities are saying it won't work, qualified people are saying it isn't practical, some have proven that it is, and that puts the Extension Services between the rock and the hard spot.

QUESTION: What really are the most practical options of the small user right now?

ANSWER: It is very practical if you are willing to use a low cost auto motor, almost new, for $2000 and hook motor to it to use as a fenerator for peak loads only at 4-5 hours a day. You are going to have to answer this question yourself.

QUESTION: Is there any practical way of saving and storing a couple months?

ANSWER: Storage time should not be over a couple of weeks, if even that long.

QUESTION: How about storing manure?

ANSWER: The longer stored, the less gas because it will de-grade. Waybright found that after 6 months, manure storage (at under 60°) was 90% effective.

COMMENT: You have to get it the first day it is produced.

QUESTION: What is the problem on gas storage over 2 weeks?

ANSWER: You would have to spend $10,000 for a large propane tank; then you would have to pay a lot of money for a compressor too.

QUESTION: Ever tried to compress it into liquid?

ANSWER: Not feasible.

QUESTION: Centrifuge to get single cell protein - 300 G's to separate?

ANSWER: Waybright doesn't think it's feasible. Centrifuge would cost about $600,000. It could produce $600,000 worth of feed stock per year on a dairy farm, and it would have to be rebuilt in 3 years. It also wouldn't pay back within three years.

COMMENT: Smaller digester - there is a couple of guide lines: (1) Don't spend over $10,000, and (2) Must have a use for the gas.

COMMENT BY VAUSE: If Waybright can build a system for $10,000 all inclusive, I could make a million dollars.

12:30 P.M. - LUNCH

COMMENT: Andriolo from PP & L: Pacific Power is definitely interested in buying output on any generation you might have. They are presently buying from 10 small plants. Co-generation has many connecting requirements, the purpose of which are to insure safety for your equipment and for PP & L's workers. The reasoning behind their willingness to buy is that they want all the power they can get to avoid the cost of plant construction.

THOUGHTS FROM THE SPEAKERS - MARCH 18, 1982 - 1:00 P.M.

WAYBRIGHT: When you generate electricity, the one thing that determines the efficiency is the load that the unit has on it. You should aim for at least 50% load and co-generation is really good. Right now co-generation is not a quick pay back for the utilities. Our utility in Pennsylvania is willing right now to sign a 5 year contract at 12% annual interest over previous years' pay.

QUESTION: Would you have to have gas storage to get highest rate?

ANSWER: Yes.

VAUSE: Bonneville Power has indicated that 2 to 3 years from now they may need increased capacity. There is a potential that our power rates are going to go up to the point that it would be feasible to start setting up for a digester now.

LANDERS: Every state will have its own regulations. The pay for output will differ. (Went into discussion on meters required by utilities: most require two. Explanation given as to how this works.)

QUESTION: How efficient is a 10 hp induction motor?

ANSWER: Synchronous is most efficient. Induction is about 3% less efficient.

QUESTION: If you have an automatic start so you can run peak load only and it shuts on and off, how will this effect the engine?

ANSWER: The shutting on and off makes more engine wear. It will have 70% of the life of a continuously run generator.

COMMENT: Most generators you would have would be small enough that the utilities could accept 100% of the time all you're putting out.

QUESTION: Did you ever run an economic analysis?

ANSWER: California did. They said it was better to add storage, buy bigger unit, and run peak and partial peak instead of continuously. Landers is in doubt about this.

QUESTION: If a guy is going to use just steam, is there a limit to how you can run pipe?

ANSWER: Waybright is transporting hot water underground about 1000 feet with success. We spent $12,000 to save $7,000 per year.

QUESTION: At what velocity does that water go through?

ANSWER: 45 gpm.

FINANCING: Landers showed figures of financed deal in California. Perennial offers a lease plan that doesn't tie up your lines of credit.

QUESTION: Have you had any trouble getting standard financing for a digester?

ANSWER: Yes, on the local level, lenders aren't used to it and aren't completely sure the system will work anyway. Too new. Not much government backing around.

QUESTION: In your travels, have you seen any other uses of the by-products?

ANSWER: No, I think it is a new area.

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